temperature-sense, as the changing of the position of the larvæ at different times of day indicates. Insects must be very insensitive to pain, or a spider would hardly eat up its own leg just after it had been cut off, as Forel observed. Ants are thus well supplied with senses, and, though their actions are largely instinctive, some control over the co-ordination of these instincts undoubtedly exists.

Another worker in the same field, Dr. H. C. McCook (*Proceedings of the Philadelphia Academy of Sciences*, part iii. 1887), contributes a note on the sense of direction in ants. The species is the *Formica rufa* of Great Britain, and the observation was made in Scotland. These ants build mounds as much as three feet high and from six to seven feet in diameter at the base. From such a mound, roads are seen to radiate. These roads are stained dark, probably by the action of the formic acid which the ants secrete; and the leaves and grass over which the road passes are worn smooth by the constant action of innumerable legs. From one such mound three roads radiated, and were traced to their termini, — three oak-trees, on the branches of which were *Aphides*, the 'milk-cows' of the ants. The directness of these roads was remarkable. The first was twenty-one paces (about sixty-five feet) long, and was almost perfectly straight from the nest to the tree. The second was twenty-three paces (seventy feet) long, and varied less than three inches from a straight line if measured from the nest to a point within two feet of the tree, where an originally straight path had been abandoned for a détour. The third road was thirty-four paces long; for six paces it ran straight, then encountered an old stump that caused a deflection, but then went directly to the tree, across a foot-path, and, as it was, the deviation was not more than three feet from a straight line. The straightness of these roads cannot be attributed to chance; and the fact that ants can see only a little way off (and especially in this mass of bracken and other plants) opens up a real problem as to the nature of a sense of direction in ants. Dr. McCook adds the mention of the remarkable feat of a Texas ant making an almost perfectly straight path 669 feet long, 448 feet of which ran under ground at an average depth of 18 inches.

THE FUNCTION OF THE CEREBRUM IN THE DOG. — In his last contribution to the physiology of the brain, the eminent physiologist at Strassburg, Professor Goltz (*Pflüger's Archiv*, 1888), gives an account of a dog from which one entire cerebral hemisphere had been removed. Here there was not, as some physiologists would expect, a paralysis and an anæsthesia on the side opposite the injured organ; but the action of the dog was quite normal, only that he preferred the side controlled by the intact hemisphere. This goes to show that in the dog one hemisphere can to a large extent perform the functions for the entire body. As a converse proof, if symmetrical regions are removed from both halves of the brain, the result is a much more serious one. An animal lacking both its frontal lobes had its intelligence much diminished, was restless, constantly moving, could not feed itself, could not hold a bone, and was a decidedly abnormal dog. A dog with both its occipital lobes gone shows marked sensory defects, but behaves much more normally than the former dog, thus indicating that the part removed is of vital importance.

A SUGGESTION FOR THE 'TELEPATHIC' THEORY. — Professor Josiah Royce has an apt word to say in regard to the cases of coincidence of a critical experience with a strong impression of danger on the part of a distant friend, which some regard as evidence of 'telepathy' (*Mind*, April, 1888). He offers as a solution of the many cases in which the evidence rests entirely on the word of a reliable witness, that the memory is the subject of a hitherto undescribed hallucination: it is an "instantaneous hallucination of memory, consisting in the fancy, at the very moment of some exciting experience, that one has expected it before its coming." As A learns of the death of B, it suddenly and vividly occurs to him that he expected B's death, and had a distinct presentiment of it. The belief might come with irresistible force, and acquire strength by reflection. One such hallucination of memory is well known: the feeling that an experience has been here before. Here we easily recognize the illusion, because we know that we do not live our lives twice; but in the other case no such corrective is at hand. If such illusions occur, marked instances of them should be found among the insane. Two cases are cited, the one of a young girl whose lover (so she says whenever any thing happens) predicted every thing to her, — her removal to another asylum, a change of physicians, and so on. The other case is that of a young man who believes that all the events of asylum-life have been told to him in a previous conversation. The news of the day is similarly anticipated. An interesting point in this case is, that the patient tells that when these (imaginary) conversations occur he pays little attention to them, but when the real occurrence takes place he vividly remembers the former conversation. His memory for real events remains quite good. Now that attention has been called to the possibility of such illusions, normal instances of them should be forthcoming.

ELECTRICAL SCIENCE.

Cost of Electrical Distribution by Transformers and Secondary Batteries.

THE attention of electricians, both in this country and in England, has been lately called to the relative values of continuous-current and alternating-current distribution. In the discussion before the English Society of Telegraph Engineers and Electricians, the majority of the speakers seemed to incline toward the alternating system, apparently relying to some extent on rose-colored reports of the successful working of plants on this side of the water. There were several members, however, who spoke strongly in favor of the continuous-current system; and one of them, Mr. Crompton, has published figures of the comparative cost of installing ten thousand 16-candle power lamps, burning simultaneously, using in the first case the continuous-current system with storage-batteries; in the second, alternating-current transformers.

WITH SECONDARY BATTERIES.

Motive power, six 166-horse power sets=996 horse-power at £8 12s	£8,700
Dynamos	4,800
Building to suit above	8,000
Charging-main, 45 tons at £80	3,600
Laying main in culvert	1,500
Distributing-mains, 12,000 yards at 16s. per yard	9,600
Service-boxes, 450 at £2	900
Batteries, four sets of 50 cells each	8,640
Regulating-gear	1,000
Total	£48,740

WITH ALTERNATING-CURRENT TRANSFORMERS.

1,450 horse-power at £8 12s. per horse-power	£12,500
Dynamos and exciters	5,540
Buildings to suit above	11,000
Charging-main	2,400
Distributing-main, 12,000 yards at 14s. per yard	8,400
Service-boxes, 450 at £2	900
Regulating-gear	500
Transformers, assuming one large one for two houses, 300 at £25 (including fixing)	7,500
Total	£48,740

These estimates may be taken for what they are worth: they probably give an approximate idea of the cost of different items. The storage system of Mr. Crompton, however, is not a complete storage system, such as will be used if secondary batteries become much more economical than at present. The cells are not located at some distance from the station, and charged by currents of high electro-motive force: they are placed *in* the station, and are only charged for a portion of the twenty-four hours, the plant remaining idle during the remainder of the day. For short distances, such as Mr. Crompton contemplates, this is possibly the best arrangement. It would have been interesting if the running expenses of the two systems had been compared, but the necessary data are hardly, at the present time, available.

ADVANTAGES OF ELECTRICITY FOR RAILROAD-WORK. — The rapid advances of the application of electricity to street-car traction brings up the question whether we cannot in the near future look to the displacement of the steam-locomotive by the electric motor. The conditions of street-car and railroad work are different: in the first, electricity is called upon to displace horses, an extremely costly motive power; in the second, it must displace steam. That it can economically replace horses has been shown

by a number of electric tramways at present in operation. The only question is, will considerations of safety and æsthetics allow the current to be economically conveyed to the cars? For instance: in the Sprague Electric Railway in Richmond, using an overhead conductor, it is costing for power about $1.70 per day per car, the cars averaging over eighty miles. This is for only twenty cars. When the full complement is running, the cost will be reduced, probably to about $1.50 per car per day. This cost is to be compared with the $5 or $6 that must be allowed per car per day for horses, at an average of, say, 60 miles per car per day. If the overhead system could be used, then, in all of our cities, there would be no doubt as to the results as far as street-car traction goes. When it comes to ordinary railroad-work, the state of affairs is very different. The question is, shall we substitute for steam, used directly, a power which is in the first place derived from steam, and which suffers the losses due to at least two transformations before it is utilized in driving the train? As far as mere economy of power-production goes, the question is easily answered: the efficiency of a stationary steam-plant is greater than that of a locomotive-engine; and the cost of a horse-power delivered to the driving-axles of the train by the electric motor would not be more for coal, attendance, and depreciation, than the same power from the locomotive, even after allowing for all the losses in the different transformations. The advantages of the electric motor are these: the driving-machinery is the simplest that it is possible to conceive of; the armature of the motor would be fitted directly on the car-axle, while the field-magnets would rest on the truck. Each axle would have its motor, and in a train every second or third car would be a motor-car. One advantage of this has been pointed out, first, probably, by Prof. George Forbes. Taking a six-car train, we would have the traction, not of four wheels, but of sixteen, supposing two motor-cars. This will enable us to make any speed that safety will allow, to start quickly, and to take at high speeds, grades that at present are inadmissible. In fact, we can dispense with a great deal of the grading that makes the construction of railroad-lines so costly. Again: on the down grades we can make our motors into dynamos feeding current into the line, — a plan due, I think, to Mr. Sprague, — instead of wasting energy by braking the wheels; and we can in the same way brake the cars when stopping. The advantages, then, are great simplicity, increased traction, allowing an increase of speed and a decrease in the cost of constructing the road, recovery of energy on down grades and in stopping. As compared with city electric tramways, such as are now in use, railroads would have the advantages of simplicity, in not requiring any gearing between the motor and car-axle, and in allowing any economical means of conducting the current to the car, and the employment of high electro-motive forces. There is one great disadvantage, however, that the future may remove, but which at present is serious. A station supplying any portion of the line will have to have a capacity equal to the maximum work that will be required of it at any time, while the mean work might be very much less than this. As the maximum may differ from the average work five or six times, we would have to equip stations of five or six times the present capacity of the locomotives, at a cost that would throw the balance in favor of the present system, unless there happened to be very considerable sources of natural power along the line. The remedy for this — a remedy which cannot be at present applied — is in equipping the stations with storage-batteries; charging them when the required power is below the average, drawing from them when it is above. We may say, then, that, with long-distance direct lighting and electric tramways, electric railways wait the development of a more perfect storage-battery to be successful.

ELECTRIC PHENOMENA PROVOKED BY RADIATION. — Very lately considerable attention has been attracted to the effect of light on the phenomena of electrical discharge, the light generally increasing the effects, allowing discharge where it would not otherwise occur. In the *Philosophical Magazine* for April, Professor Righi gives a preliminary account of some interesting experiments he is trying in the same field. Two metals, one in the form of a disk, the other a net, are placed opposite one another. One of the metals, A, is connected with one pair of quadrants of an electrometer; the other metal is connected with the other pair and the earth; and the needle is charged. If A is illuminated, a deflection is obtained which reaches a maximum in a time which is shorter the nearer the irradiating source and the larger the surface of the metals. The sun's light does not produce this effect in a marked way: the magnesium light is more active; the voltaic arc gives the best results. It is probable that the ultra-violet rays are the most active. Four of these 'photo-electrical cells' are connected in series, and give the same results as ordinary cells in series on open circuit.

HEALTH MATTERS.

Portagiousness of Consumption.

IN a recent paper presented to the Medical Press Association of St. Louis, Dr. William Porter discusses the 'portagiousness of phthisis.' He prefers the word 'portagious,' because it conveys a more exact idea of the manner of transmission of phthisis than either 'contagious' or 'infectious.' In his paper the term 'phthisis' is used to denote that class of disease to which belongs the large majority of cases of slowly progressive pulmonary inflammations; i.e., chronic tubercular phthisis.

Dr. Porter propounds the following question: 'Have we reasonable evidence that the products of, or emanations from, a phthisical subject may be carried to, received by, and cause like disease in, one previously free from phthisis?' The answer to this question he thinks must be answered in the affirmative, and quotes the following experiments as sustaining this view. In experiments made by Tappeiner in 1883, tuberculous sputa being inhaled by eighteen healthy animals, tubercles in both lungs, and pleura, were afterwards found in seventeen. That record of Koch's work found in the second volume of the 'Imperial Health Reports,' shows, that, after the inhalation of material from phthisical cavities, the rabbits and guinea-pigs under observation had, within twenty-eight days, tubercles throughout the lungs of all, and in the liver and spleen of some. The carefully conducted investigations of Cadeac and Mullet, recently published, show, that while no positive result was obtained from compelling rabbits and guinea-pigs to inspire air exhaled by phthisical patients, yet when air was used collected from near the beds of hospital inmates, the air presumably carrying particles of sputa, two out of twelve guinea-pigs acquired tubercle.

The writer refers to some experiments which he made, to determine this point. "Three healthy guinea-pigs were selected. One was inoculated with phthisical sputa, and placed in a small box with one of the others. The third was confined in a box in an adjoining room. They were cared for alike, and had similar food. In four weeks the first one died, and the examination showed tubercle in the lungs, and a large cheesy gland near the point of inoculation. Three weeks after, the second animal sickened and was killed. I found small granulations scattered through both lungs, at some points aggregated; and in the right lung were two nodules, having a soft cheesy centre. The third guinea-pig, examined three months later, had no evidence of tubercle or other disease."

The only experiment upon a human subject was made by Drs. Demet, Pararky, and Zallories, of Syra, in Greece, who inoculated, with sputa from a phthisical patient, a man whose history afforded no suspicion of tubercle, and whose lungs were healthy, but who had gangrene due to femoral embolism, and who would not permit amputation. In three weeks, auscultation revealed evidences of disease at the right apex. Thirty-eight days after the inoculation, the man died from gangrene, when it was found that the upper right lobe had seventeen small tubercles and two granulations in the apex of the left lung.

In an inquiry into the transmissibility of phthisis, made by the Collective Investigation Committee in London, two hundred and sixty-one answers were received from physicians in family practice, affirming the proposition that phthisis may be communicated from the sick to the well; and evidence was given in proof of the statement. One hundred and ninety-two observers recorded cases where both husband and wife became phthisical, in one hundred and thirty cases there being no phthisis in the family of the one to whom the disease was thought to have been transmitted.

Some of these cases were very interesting. Dr. Spriggs of Great Bedford instanced the case of Miss R., aged 48, a dressmaker, who, living in rather a lonely cottage at C., Bedfordshire, had three ap-